CLAIMS

What is claimed is:

1. A method for recovering data from a plurality of signals received in a shared spectrum, the plurality of signals experiencing a similar channel response, the method comprising:

sampling a composite signal including the plurality of received signals, producing a received vector;

estimating a channel response of the composite signal;

extending the received vector;

extending the channel response;

channel equalizing the received vector using the extended channel response, producing a spread vector; and

despreading the spread vector to produce data of the plurality of signals.

2. The method of claim 1 wherein a time interval between two successive samples in each extended received vector is the chip duration.

3. The method of claim 1 wherein a time interval between two successive samples in each extended received vector is a fraction of the chip duration.

4. The method of claim 1 further comprising:

computing a first column of a circulant matrix based on estimated channel response and noise power;

decomposing a received vector circulant matrix in a fast Fourier transform (FFT) domain;

decomposing a channel response circulant matrix in the fast Fourier transform (FFT) domain;

reconstructing the received signal vector resulting in an extended signal vector;

computing the composite spread signal vector; and

despreading the composite spread signal.

5. A base station including a communications receiver, the receiver comprising:

an antenna for receiving radio frequency (RF) signals;

a sampling device coupled to the antenna for producing a chip rate received vector;

a channel estimation device coupled to the sampling device for determining a channel impulse response for the received vector; and

a single user detector (SUD) coupled to the sampling device and the channel estimation device for estimating a data vector using an extended algorithm which extends the received vector and the channel impulse response.

6. The base station of claim 5, wherein the SUD comprises:

a channel equalizer for using the channel impulse response to determine a spread vector; and

a despreader coupled to the channel equalizer for despreading the spread vector to estimate the data vector.

7. A wireless transmit/receive unit (WTRU) including a communications receiver, the receiver comprising:

an antenna for receiving radio frequency (RF) signals;

a sampling device coupled to the antenna for producing a chip rate received vector;

a channel estimation device coupled to the sampling device for determining a channel impulse response for the received vector; and

a single user detector (SUD) coupled to the sampling device and the channel estimation device for estimating a data vector using an extended algorithm which extends the received vector and the channel impulse response.

8. The WTRU of claim 7, wherein the SUD comprises:

a channel equalizer for using the channel impulse response to determine a spread vector; and

a despreader coupled to the channel equalizer for despreading the spread vector to estimate the data vector.

9. A base station including a communications receiver, the receiver comprising:

an antenna for receiving radio frequency (RF) signals;

a sampling device coupled to the antenna for sampling the received signals at a multiple M of the chip rate, producing M received vector sequences;

a channel estimation device coupled to the sampling device for determining a channel impulse response for each received vector; and

a single user detector (SUD) coupled to the sampling device and the channel estimation device for estimating a data vector using an extended algorithm which extends the received vector and the channel impulse response.

10. The base station of claim 9, wherein the SUD comprises:

a channel equalizer for using a channel impulse response to determine a spread vector; and

a despreader coupled to the channel equalizer for despreading the spread vector to estimate the data vector using transmission codes in the received signals.

11. A wireless transmit/receive unit (WTRU) including a communications receiver, the receiver comprising:

an antenna for receiving radio frequency (RF) signals;

a sampling device coupled to the antenna for sampling the received signals at a multiple M of the chip rate, producing M received vector sequences;

a channel estimation device coupled to the sampling device for determining a channel impulse response for each received vector; and

a single user detector (SUD) coupled to the sampling device and the channel estimation device for estimating a data vector using an extended algorithm which extends the received vector and the channel impulse response.

12. The WTRU of claim 11, wherein the SUD comprises:

a channel equalizer for using a channel impulse response to determine a spread vector; and

a despreader coupled to the channel equalizer for despreading the spread vector to estimate the data vector using transmission codes in the received signals.

13. A single user detector (SUD), comprising:

(a) a channel equalization stage, wherein a composite spread signal is estimated using a minimum mean squared error (MMSE) equalizer; and

(b) a despreading stage for estimating symbol sequences detected by the SUD.

14. A communications system comprising:

a base station; and

a wireless transmit/receive unit (WTRU) in communication with the base station, wherein the WTRU comprises:

an antenna for receiving radio frequency (RF) signals;

a sampling device coupled to the antenna for producing a chip rate received vector;

a channel estimation device coupled to the sampling device for determining a channel impulse response for the received vector; and

a single user detector (SUD) coupled to the sampling device and the channel estimation device for estimating a data vector using an extended algorithm.

15. The communications system of claim 14, wherein the SUD comprises:

a channel equalizer for using the channel impulse response to determine a spread vector; and

a despreader coupled to the channel equalizer for despreading the spread vector to estimate the data vector using transmission codes in the received signals.

16. A communications system comprising:

a wireless transmit/receive unit (WTRU); and

a base station in communication with the WTRU, wherein the base station comprises:

an antenna for receiving radio frequency (RF) signals;

a sampling device coupled to the antenna for producing a chip rate received vector;

a channel estimation device coupled to the sampling device for determining a channel impulse response for the received vector; and

a single user detector (SUD) coupled to the sampling device and the channel estimation device for estimating a data vector using an extended algorithm.

17. The communications system of claim 16, wherein the SUD comprises:

a channel equalizer for using the channel impulse response to determine a spread vector; and

a despreader coupled to the channel equalizer for despreading the spread vector to estimate the data vector using transmission codes in the received signals.

18. In a wireless communication system, a method for performing an extended algorithm (EA) with over-sampling, the method comprising:

(a) the system receiving a signal $\underline{r}^{(1)}$ at a first input and a channel impulse response $\underline{h}^{(1)}$ at a second input;

(b) zero padding the received signal $\underline{r}^{(1)}$ in the tail until the length of sequence achieves length Lm and denoting the extended sequence after zero padding as $\underline{r}_E^{(1)}$;

(c) zero padding the channel impulse response $\underline{h}^{(1)}$ in the tail until the length of the extended sequence achieves length Lm and denoting the extended sequence after zero padding as $\underline{u}_1$;

(d) performing a discrete Fourier Transform (DFT) or fast Fourier transform (FFT) on $\underline{r}_E^{(1)}$ such that $F(\underline{r}_E^{(1)})$;

(e) performing DFT or FFT on $\underline{u}_1$ such that $F(\underline{u}_1)$;

(f) conjugating $F(\underline{u}_1)$ such that $F(\underline{u}_1)^*$;

(g) multiplying the sequences $F(\underline{r}_E^{(1)})$ and $F(\underline{u}_1)^*$ such that $F(\underline{r}_E^{(1)})\cdot F(\underline{u}_1)^*$, wherein for M sampled sequences, steps (b) - (g) are repeated for sampled sequences 2,...,M such that $F(\underline{r}_E^{(m)})\cdot F(\underline{u}_m)^*$, m = 2,..., M.

19. The method of claim 18, wherein all of the M sampled sequence results obtained in steps (b) – (g) are added element-to-element such that $\sum_{m=1}^{M} F(\underline{r}_E^{(m)})\cdot F(\underline{u}_m)^*$, M = 1,2,...,M.

20. The method of claim 19 further comprising:

(h) generating a channel correlation vector $\underline{g}$ using extended channel response sequences $\underline{u}_1,\ldots,\underline{u}_M$ such that $\underline{g} = \sum_{m=1}^{M} \underline{g}^{(m)}$;

(i) performing DFT or FFT on channel correlation vector $\underline{g}$ such that $F(\underline{g})$;

(j) dividing element-by-element the result in step (g) by the result in step (i) such that $\frac{\sum_{m=1}^{M} F(\underline{r}_E^{(m)}) \cdot F(\underline{u}_m)^*}{F(\underline{g})}$;

(k) performing an inverse DFT or inverse FFT on the result of step (j) such that $F^{-1}(\frac{\sum_{m=1}^{M} F(\underline{r}_E^{(m)}) \cdot F(\underline{u}_m)^*}{F(\underline{g})})$; and

(l) despreading the result of step (k) to obtain the estimated data symbols $\hat{\underline{d}}$.

21. A wireless communication system for performing an extended algorithm (EA) with over-sampling, the system comprising:

(a) means for receiving a signal $\underline{r}^{(1)}$ at a first input and a channel impulse response $\underline{h}^{(1)}$ at a second input;

(b) means for zero padding the received signal $\underline{r}^{(1)}$ in the tail until the length of sequence achieves length Lm and denoting the extended sequence after zero padding as $\underline{r}_E^{(1)}$;

(c) means for zero padding the channel impulse response $\underline{h}^{(1)}$ in the tail until the length of the extended sequence achieves length Lm and denoting the extended sequence after zero padding as $\underline{u}_1$;

(d) means for performing a discrete Fourier Transform (DFT) or fast Fourier transform (FFT) on $\underline{r}_E^{(1)}$ such that $F(\underline{r}_E^{(1)})$;

(e) means for performing DFT or FFT on $\underline{u}_1$ such that $F(\underline{u}_1)$;

(f) means for conjugating $F(\underline{u}_1)$ such that $F(\underline{u}_1)^*$;

(g) means for multiplying the sequences $F(\underline{r}_E^{(1)})$ and $F(\underline{u}_1)^*$ such that $F(\underline{r}_E^{(1)})\cdot F(\underline{u}_1)^*$, wherein for M sampled sequences, steps (b) - (g) are repeated for sampled sequences 2,...,M such that $F(\underline{r}_E^{(m)})\cdot F(\underline{u}_m)^*$, m = 2,..., M.

22. The system of claim 21, wherein all of the M sampled sequence results are added element-to-element such that $\sum_{m=1}^{M} F(\underline{r}_E^{(m)})\cdot F(\underline{u}_m)^*$, M = 1,2,...,M.

23. The system of claim 22 further comprising:

(h) means for generating a channel correlation vector $\underline{g}$ using extended channel response sequences $\underline{u}_1,\ldots,\underline{u}_M$ such that $\underline{g} = \sum_{m=1}^{M} \underline{g}^{(m)}$;

(i) means for performing DFT or FFT on channel correlation vector $\underline{g}$ such that $F(\underline{g})$;

(j) means for dividing element-by-element the result in step (g) by the result in step (i) such that $\dfrac{\sum_{m=1}^{M} F(\underline{r}_E^{(m)})\cdot F(\underline{u}_m)^*}{F(\underline{g})}$;

(k) means for performing an inverse DFT or inverse FFT on the result of step (j) such that $F^{-1}\left(\dfrac{\sum_{m=1}^{M} F(\underline{r}_E^{(m)})\cdot F(\underline{u}_m)^*}{F(\underline{g})}\right)$; and

(l) means for despreading the result of step (k) to obtain the estimated data symbols $\hat{\underline{d}}$.